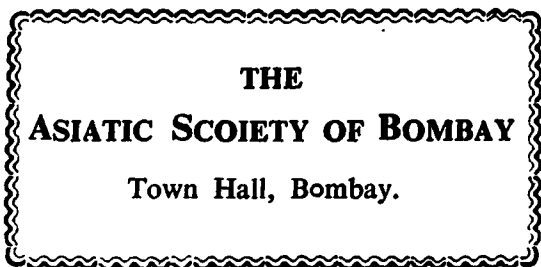


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*Notes of a Voyage to Kerguelen Island to observe
the Transit of Venus, Dec. 8, 1874.*

BY THE REV. S. J. PERRY, F.R.S.

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I.

DURING the course of the past year letters and articles and reports were appearing in newspapers and periodicals on a subject which under ordinary circumstances could scarcely be expected to create much popular excitement. The exact determination of the sun's distance is doubtless a matter of deepest concern to every one interested in physical astronomy, but the world at large would never have manifested so much interest in the investigation had it been a mere matter of deep research, pursued in the quiet retirement of a private study, and then given to the world in the publications of some learned society. Neither was the bearing of this knowledge on the correction of our lunar tables, and the consequent practical improvement of our methods for determining longitudes, leading directly to an increased security of our mercantile navy, brought sufficiently before the public to make that an adequate foundation for the interest shown. But it was because the question was taken up by all civilized Governments, because England and France, Russia and Germany, America and other nations, voted large sums, and sent out war vessels to distant lands, for the purpose of solving the problem, that it became naturally a matter of public importance. In 1874 much was written about what had to be done, and how the work was to be carried on. And now a not infrequent question remains to be answered: How have the proposed plans been actually carried out? what has been done? Do we know the precise distance of the sun from the earth? Have we been successful in obtaining a closer approximation to the solar parallax by the observations of the transit of Venus than that to which we had already attained by other and less expensive methods?

If we consider the mass of observations accumulated on the 8th and 9th of December last; the hundreds of photographs that must be accurately measured by instruments still being constructed for this express purpose; the numerous measures, taken with heliometer and double-image micrometer, of cusp and diameter and distance of limbs, that severally require long calculations and perfect instrumental corrections before they can teach us anything of the solar distance; and, finally, the observed times of contact, the accuracy of which has to be separately tested before the results can be combined with those of other stations; we shall not be astonished at having to wait some time for a satisfactory answer. But when we, moreover, remember that for the application of these observations made on the day of the transit, it is necessary to possess a most exact knowledge of the longitude of the observer in order to apply the most effective method of investigation; that the longitude in many cases depends solely on lunar observations; that thirty meridional transits of the moon and one hundred double observations of lunar altitude or azimuth were required for a single station; and that the reduction of a single measure of the moon's altitude or azimuth is a good six hours' work for a practised computer; it will not be a matter of astonishment to hear that the complete and perfect answer, as perfect as may be given, to the question before us, cannot be expected in the course of a few months, but will require years. The last transit of Venus was observed in 1769. It was not till 1837 that Encke completed the reduction of the observations which were then made. It was in 1869, exactly a century after the transit, that Stone received the gold medal of the Royal Astronomical Society for his correction of Encke's value. Probably we may not have to wait a century this time for the most complete solution of our problem; and we can at once learn much that bears upon the subject, and that will serve to reassure those who may have had misgivings as to the wisdom of the undertaking, or the attainment of its end.

Among the many expeditions sent out by England or her colonies for the observation of the transit of Venus last year, few perhaps attracted more attention or excited more interest than that destined for the Land of Desolation. Its excellent geographical position gave it special claims, situated as it is at the spot best suited as a south station for the application of Halley's method of total duration, and as an east station for

retarded ingress to pair with Honolulu in Delisle's method, and at the same time being nearly as good for the direct as for the indirect mode of attack. And then the desolate situation, almost three thousand miles away from any habitable spot ; the dreary aspect of an island of rock and lake and bog, without man or beast or tree to break the monotony of its loneliness ; and most of all, the fearful approach through mist and storm, with waves the greatest in the world, and winds blowing a gale five days out of every seven—all tended to create a sympathy for those who had the honour of being intrusted with this important post.

The first detachment of astronomers left England for Kerguelen on May 23rd, in the S.S. *Elizabeth Martin*, and after touching at Ascension Island and St. Helena, arrived safe at the Cape of Good Hope. These consisted of Lieut. C. Corbet, R.N., Lieut. S. Goodridge, R.N., Mr. J. B. Smith, Corporal Wright, R.E., and Sapper Hibbert. Lieut. Corbet, who was in charge of the party during the voyage and until the arrival of the other observers, employed his time at the Cape in constructing the necessary dwellings and huts for instruments, and in preparatory observations for the accurate determination of time.

About a month later, the S.S. *Windsor Castle* left the south West India Dock for the Cape, having on board the Revds. S. J. Perry and W. Sidgreaves, S.J., Lieut. G. E. Coke, R.N., and Sapper Wilson. These completed the staff of astronomers and photographers destined for Kerguelen. The Rev. A. E. Eaton, who accompanied the expedition as naturalist, left England a few days later.

The S.S. *Windsor Castle* touched at Dartmouth and Madeira on our outward passage, and after a quiet and agreeable journey, made doubly pleasant by the kind attentions of our excellent commander, Captain Howson, we reached Cape Town at early morn on July 20th. The incidents of this first part of our journey were few, and scarcely of general interest. It was pleasant to stand at night on deck, and view the gorgeous phosphorescence of the Atlantic, which often appeared like a lake of fire ploughed up by our vessel's prow, and by day to watch the myriads of flying-fish, with now and then a shoal of porpoises or benitos, or a chance whale, or a small fleet of "Portuguese men-of-war," with their tiny blue sails trimmed so elegantly with pink. The birds were few : some stormy petrels

and Cape pigeons, varied by an occasional albatross. On the night between July 2nd and 3rd, there was a fall of red sand, hundreds of miles from land, and in the morning the fine dust still covered the deck and adhered to the rigging. The starry heavens, the moon, Venus and Jupiter, the glowing milky way, and the glorious clusters of stars, all delighted us for many an hour in the cool evenings of the tropics; but the Southern Cross, that wonder of the heavens, about which poets and poetical astronomers love to sing, oh, what a disappointment!—instead of a cross, a badly formed diamond shape, and in place of brilliant stars only one poor first magnitude star, two of the second or third, and a bad fourth. I watched it night after night; I tried to admire it; I wished to find something in it to praise, but it was always a puzzle to me how any one could bestow on it more than a passing glance, when such constellations as the Centaur and the ship Argo were in view.

On our arrival at the Cape we found that the dockyard at Simon's Bay had been brought into active requisition. An observatory and dwelling for our secondary Kerguelen station, and a store-house and naturalists' wing for the dwelling of our principal station, were almost ready, and many necessary articles had been added to the stores which lay waiting their departure at Simon's Bay. The British Government had appointed H.M.S. *Encounter*, Captain Bradshaw, and H.M.S. *Supply*, Captain Inglis, to convey the astronomical expedition to Kerguelen, and when we visited Captain Bradshaw, on July 24th, his vessel was in harbour, where he was making active preparations to receive the astronomers on board, and removing the guns to make way for some of the six hundred packages which formed the transit luggage. The lifting piece of the screw of the *Encounter* had unfortunately been broken during the Ashantee war, but it was confidently expected that the damage could easily be repaired at Simon's Town. In the meantime some useful work could be carried on at the Cape. Lieutenants Corbet and Coke made observations with the altazimuth at the observatory, the Rev. W. Sidgreaves took a series of determinations of the magnetic elements, Lieutenant Goodridge superintended the dockyard preparations, and Mr. J. B. Smith, Corporal Wright, and Sappers Hilbert and Wilson, practised wet and dry-plate photography. On August the 5th the *Swatara*, U.S.N., Captain Chandler, arrived at the Cape, having on board the astronomers for the five southern transit of Venus stations chosen by the Americans. We at once put ourselves

into friendly relations with Captain Ryan, U.S.N., chief of the American Kerguelen party, and we learnt from them that they intended to occupy the exact site that had been indicated by H.M.S. *Challenger* as the most favourable for the observation of the transit. The Germans, as we had previously been informed, wished to station themselves at Betsy Cove, which Captain Nares had suggested as the next best site for the observations. The weather at Kerguelen being the enemy most to be dreaded by the astronomers, it was particularly objectionable to crowd the observers together, as one small cloud might thus spoil all. We therefore determined to occupy the third position indicated by the vessel sent by the British Government to explore for us, or to find a new station for ourselves. This made us very anxious to start for Kerguelen as soon as possible. But on the very day of the arrival of the *Swatara*, we learnt for the first time that H.M.S. *Volage* had been commissioned to replace the *Encounter*. The news of the accident to the lifting portion of the screw of the *Encounter* had been telegraphed to the Admiralty, and their lordships, who throughout the preparations gave their most cordial support to everything that was likely to promote the complete success of the undertaking, had at once put another vessel in commission. The encouragement received from this interest in our expedition was, however, partly counterbalanced by the loss we sustained in being deprived of the aid and support of Captain Bradshaw and of the other officers of the *Encounter*, who had throughout shown the liveliest interest in everything connected with the work for the transit.

The next day, Commodore Sir W. Hewett, V.C., arrived in H.M.S. *Active*, followed shortly by Captain Inglis, in command of H.M.S. *Supply*. On the 8th of August we had the pleasure of entertaining the American astronomers, who were to be our companions on the Island of Desolation, and on the 10th we drove over from Cape Town to Simon's Bay with Captain Chandler, to pay our respects to the Commodore. The American captain, now heart and soul in his work, had at first felt some reluctance, as he told us, to engage in the arduous undertaking of landing five parties of astronomers at different points of observation in the southern seas. Having but lately retired from active service in the United States navy, he was living very happily with his family in a farm of his own at P——, when he received a letter from the Minister of Marine requesting him to take the command of the scientific expedition for the obser-

vation of the transit of Venus. He declined the offer; but the Minister, not wishing to lose the services of so able an officer in a voyage of such unusual difficulty, pressed him to accept, reminding him that he was sure thus to "live in history," "I should much prefer to live in P——," was Captain Chandler's ready reply, though the service of his country had finally more weight in his councils than even the enjoyments of a quiet country home.

Nothing could exceed the kindness and attention which we received on this and on all future occasions from Commodore Sir W. Hewett, who did all in his power to carry out fully the objects of the expedition, himself inspecting the preparations, and giving encouragement to those concerned in it.

Sir H. Barkly, Governor of the colony, entertained the American and English astronomers on the 13th; and on the 15th a farewell dinner was given on board the *Swatara* to those who were so soon to follow the noble ship in her perilous course from the Cape to Kerguelen. On the 17th, the American vessel left the Cape for the Crozets and Kerguelen, and we wished them a hearty God speed, though we sorely felt being left behind when the time of preparation on the island was so precious.

As an extra security against the coming rough weather, which we felt sure we must meet in our southern voyage, H.M.S. *Supply* was placed on the slip at Simon's Bay to undergo all needful repairs, and to be fresh painted. On August 26th she was to return to her proper element, but she proved refractory, and we had the mortification to learn that she had fallen on her side whilst on the slip. Fortunately no real damage was done, and on the morrow Captain Inglis had the pleasure of seeing his beautiful little vessel descend smoothly into the water without further let or hindrance. Much had been removed to lighten her, but the energy of the captain was indefatigable, and in a few days all was in its place again and the work of loading commenced. As it was known that the *Volage* would be unable to carry out anything except a few observers, and a small amount of personal luggage, all the instruments, houses, and stores, as well as the coals and provisions for both vessels had to be stowed away on board the *Supply*. This was no easy matter, but most difficulties can be overcome by goodwill and energetic perseverance, and neither of these were wanting in this case.

On the 8th of September, a salute of heavy guns, which shook the windows of the houses, announced the arrival of H.M.S. *Volage*, and we lost no time in going on board and making ourselves acquainted with the orders and intentions of her captain. The idea was entertained of landing us on Kerguelen, of then going to Australia, and of finally picking us up again about a week or a fortnight after the transit was over. This plan, we at once saw, seemed likely to disturb all our arrangements, depriving us of the assistance of those officers who were absolutely necessary for the observations, and making it impossible to satisfy the most important of all our instructions, which was to secure a longitude that should be fundamental for the Kerguelen seas. Captain Fairfax laid his orders and plans before the Commodore, Sir W. Hewett, and the latter at once requested me to record in writing my views and instructions on this important matter. This was done at once, and at considerable length, and we had the great satisfaction to find that the Commodore and Captain Fairfax most cordially entered into our views. This reflects the more credit on the self-sacrifice of the captain and his officers, as they were commissioned in great haste in England, and were consequently unable to provide themselves at all adequately with many comforts which might be considered almost an absolute necessity in the desolate land we were about to inhabit. But the success of the expedition demanded the sacrifice, and it was most generously made. For our own part we were determined that no consideration should make us flinch where the astronomical interests of the expedition were at stake, but it is but fair to remember that the question of food during our stay at Kerguelen did not affect us so much personally, as the Government had supplied the astronomers most lavishly not merely with the necessaries, but even with the luxuries of life.

The morning of September 17th, just a month after the sailing of the *Swatara*, U.S.N., was at last fixed for our departure. H.M.S. *Volage* got up steam, a hawser was lowered from the main deck, and in a few minutes we should have been towing H.M.S. *Supply* towards the westerly gales that were to carry us to the Island of Desolation, when we met with another accident that might have proved as disastrous as any that preceded it. The anchor which held the *Volage* gave way under the increase of strain put upon it by the weight of the *Supply*, and both ships began drifting at a rapid rate towards the shore.

This was perceived in an instant, and the command, "Full steam ahead," saved us from our perilous situation, but in obeying it our screw unfortunately got foul of the towing hawser. The enormous rope wound itself round and round the iron screw, and it required about two days of constant labour to cut off the cable. The ship's divers were incessantly at work under water with saw and hammer and chisel, but as time was most precious, H.M.S. *Supply* received orders at noon on the 18th to steam out alone, and to hold her course due south. In the evening our screw was again free, and we lost no time in weighing anchor. When morning broke we at once sighted the *Supply* and we steamed along in company for two or three days until we fell in with the westerly winds. Our course from this point was as straight as an arrow for Kerguelen, and we soon parted company with our companion, which could not be expected to keep pace with one of the swiftest vessels of the British Navy. Each day now became the exact counterpart of that which preceded it. The sea-birds hovered around us in great numbers, and followed the vessel day and night, appearing scarcely ever to require a rest upon the waters. Our largest companions were the albatrosses, and it was delightful to see them sweep majestically by, as if it required no effort to advance with the rapidity of a hurricane. But the beautifully easy flight and the plumage of the Cape pigeons made them our favourite followers. The wing of one of these had a feather pulled out of place by a string thrown out at the stern of the vessel, and we could see this bird day after day in company with his fellows apparently unconscious of the injury he had sustained. We should have sighted the Crozets on October 2nd, and tried to communicate with the American astronomers under Captain Redmond, U.S.E., whom we then supposed to have been landed on one of the islands, had we not found ourselves abreast of them about the first watch of the night. Not wishing to lose time we sailed past, and when morning broke we were too far on our course to see even the outline of the land.

Nothing of any special interest occurred for the remainder of the voyage until we came almost within sight of Kerguelen, when the strength of the wind had become so great that it was deemed imprudent to approach nearer the unknown shore. For two days and nights we lay off the land, but not in sight of it, on account of the thick fog which habitually prevails

in those seas. The waves were enormous, and we could not but enjoy the grandeur of the spectacle in spite of the very great inconvenience, not to say suffering, to which we were exposed. Four days and nights the mighty waves had been continually washing over the *Volage*, and the poor sheep and goats and oxen, with which the deck was crowded, were truly a piteous sight. As much care as possible was taken of them, but when the storm was at its height the upper deck became a perfect slaughter-house, and thirty or more carcasses had to be thrown overboard on one morning. The rolling of a long vessel with heavy guns on its upper deck was necessarily very great in such a sea (being often more than 40° on either side), and the consequences were at times rather more than comic. On one of the days we had just finished dinner under circumstances of no ordinary difficulty, when suddenly a crash was heard overhead, and down came a portion of a wave on to the middle of the table. All was of course capsized in an instant, and the officers on one side had to sustain the weight of the table and of those gentlemen who had been thrown on it from the opposite side. A few minutes previously another wave had forced its way down into the steerage, and the chests of the younger officers, containing all their clothes and linen were completely deluged with salt water, not a stitch of dry clothing being left for a change. Although we were well battened down, the sea flooded all the cabins, as well as the wardroom and gunroom. A group of eight officers were standing under the poop when a wave washed them clean off their legs, and dashed them against the door of the Captain's cabin; some were completely under water. It seemed probable that the ordinary fastenings of our cutter on the weather side would be unable to stand against the strength of these waves, and therefore extra ropes were at once applied; but all in vain, for the men had hardly completed this work, when a wave huger than its fellows rose aloft and tore the large boat clean away from the vessel. It was truly fortunate that we had no man overboard during these gales, as it would have been impossible to effect a rescue. At last the trials of the voyage came to an end, the strength of the wind abated a little, the sky cleared, and on the morning of the 8th of October we sighted the land on the north-east of Kerguelen. Our course was at once steered for Royal Sound, and as we approached we found that the whole island, as far as eye could reach, was

completely buried in snow. This was the end of spring for the southern hemisphere, so we had pleasant prospects of rambles in snow-shoes over rugged hills and half-frozen marshes and bogs. We entered Royal Sound without any difficulty, and steamed straight to Island Harbour, where we cast anchor at four p.m.

II.

THE pleasant feeling of once again beholding land, after a long and perilous journey over an almost unknown sea, was greatly enhanced by perceiving on our arrival that we were not alone in the Land of Desolation. To our surprise, we found two schooners in Island Harbour awaiting a favourable wind to carry them to Heard Island for the seal fishery. This was particularly fortunate, as the sealers were best able to give us the information we so much required, to guide us in the choice of good stations for our observations.

The day after our arrival was necessarily spent in putting things a little straight after the dreadful upset of the previous week, but Captain Fairfax managed to find time to make all necessary inquiries of Captain Bailey of the *Emma Jane*, who kindly volunteered to be our guide on the following day. Before leaving Simon's Bay, the eight chronometers, on which our longitude runs were to depend, had been housed with special care in the chart-room of the *Volage*, and then telegraphic signals had been received from the Royal Observatory at Cape Town on two separate days to determine accurately the errors and rates of these instruments. It now remained to find without delay our local time, in order to obtain the difference of longitude between Kerguelen and the Cape. This was done at once by Lieut. C. Corbet, R.N., who landed on Hog Island, so named after an enormous animal kept by the sealers near their wooden hut, and with the Delarue altazimuth a series of observations of the sun's altitude were taken, which gave most satisfactory results. Messrs. Sidgreaves and Perry landed at the same time with the magnetic instruments, but the frequent falls of snow prevented their obtaining any other magnetic elements except the declination. Lieutenants Kane and Vivian very kindly assisted us in landing and erecting the instruments.

The next morning a heavy fall of snow and a strong south-west wind precluded all hope of attempting the exploration we

had planned overnight, but at six a.m. the following day we were able to start in our steam pinnace, with the life-boat in tow, under the guidance of Captain Bailey. The anchorage at Island Harbour, which is protected by three large and one smaller island, is situated near the centre of Royal Sound, a large bay covering an area of more than a hundred square miles, with many islands scattered about it, principally in the west and south portions, some of which are several miles in length.

On our way to the spot within the Sound which Captain Bailey deemed most likely to suit our purposes, we passed an island, which almost realized the descriptions given of Kerguelen by the seaman Nunn, who was left there with a few companions in 1825. Speaking of midsummer, he says: "The cold was so intensely painful that, to avoid its effects, we were induced to bury ourselves in the snow, where we remained for three hours . . . The frosts are frequently intense: the ponds or lakes amongst the rocks in various parts of the island would be covered with ice of great thickness in the course of one night: even in the summer months this would frequently take place." And in another place he gives an extraordinary account of an ice-barred cavern: "The water, that usually falls in an elegant and gentle cascade from the rocks over the mouth of this cavern, appeared to have been arrested by the frost, forming itself into the crystal pillars which sealed its entrance . . . Within were no less than fourteen young sea-elephants completely imprisoned . . . They had probably resorted to this place for protection from the inclemencies of the weather; and upon the sudden occurrence of frost, which is usual in this climate, the ice had sealed the entrance and prevented their escape." The sight we witnessed on October 11th was less romantic, but it amazed us not a little, for the whole of the steep rocky shores of the island we were passing were partially covered with enormous icicles, which must have been formed by a very rapid congelation of the melted snow or rain torrents.

As the sea was smooth we reached our destination in a few hours, and there we were fortunate enough to find at once a station which offered every advantage we could desire, both on land and sea. The site was well protected by hills on the north and west, but not in such a way as to interfere with the horizon. The foundations for the instruments were the

solid rock, and the supply of fresh water was excellent and abundant. For the vessels the anchorage was all that could be desired, and the landing place for the goods easy of access and well protected.

Having settled upon this favourable spot for our primary station, we steered southwards in search of a second position, but the sun was getting low, and our supply of coal still lower, before we reached the spot to which Captain Bailey was guiding us, so we returned to our ship, not, however, without requiring the aid of our life-boat and of a whaler to help us through the kelp.

H.M.S. *Supply* had in the meantime anchored in Island Harbour, all well, having weathered the storms even better than we had done, but with the loss of all her live stock. The officers who arrived in her brought letters from the Cape for Captain Ryan, chief of the American Kerguelen Expedition, and they were, therefore, immediately rowed across Royal Sound in a whaling boat to Molloy Point, where the American station was already established on the spot indicated by H.M.S. *Challenger*.

The next morning the two schooners started with a fair but gentle breeze for Heard Island, and we quickly followed them in our steam-launch to examine Mutton Cove, a point for observations near the south entrance to the Sound, which had been indicated by Captain Bailey. This place was not found to be as favourable as we expected, so we returned at once towards our vessels. The wind had meanwhile freshened a little, and our steam power proved insufficient, as we could barely stem the waves. Two ways out of our difficulty were open to us, if we wished to avoid spending the night without food in an open boat, or on a rock to leeward—either to hammer down our safety valve, which would give us greater steam power, or to go in search of aid in the lifeboat which we had in tow. The more expeditious course was taken, and we regained our vessels with only the loss of a little time.

Preparations had been made for departure during our absence, and the *Volage* and *Supply* left Island Harbour for our chief astronomical station the same afternoon. To save time the steam-launch was towed astern of the *Volage*, and not content with the delay it had caused us in the morning, it now went through a more serious evolution by disappearing under the waves. The *Swatara*, U.S.N., lost her steam cutter on the other side the

Sound in a very similar manner, but we managed to save ours⁹ at the expense of anchoring for the night near the spot where she sank. Next morning we were again under steam, and arrived without further accident at our new home, which was soon christened Observatory Bay. As soon as we had dropped our anchors, we went on shore to mark out the exact sites for our dwelling, storehouse, and principal observing huts. Captain Fairfax was on shore in the afternoon arranging a shed for the cattle that had survived the storms.

The ground which we had chosen for the observatory buildings was fairly level, and consisted partly of the bare rock, and partly of a soft moist soil covered with a large species of moss or azorella, with here and there some Kerguelen cabbages and other plants. Our first care was to drain the ground destined for our dwelling and observatories, and to build a pier for landing the heavy huts, and instruments, and stores, but at the same time preparations were made for laying the foundations of our instruments without delay. The erection of the pier and the landing of the goods was confided to the care of Lieutenant Vivian, who had at his command a large working party of marines and blue jackets from H.M.S. *Volage*. Both men and officers aided us with right good will, and it would be difficult to overrate the assistance and encouragement we received on this, and on every other occasion, from Captains Fairfax and Inglis, who were in command of the two vessels of the expedition.

It was far from an easy task to establish an observatory so completely equipped as that at our primary station. After the draining of the ground, the building of a landing pier, the unloading of the *Supply*, which carried more than six hundred cases, some of which weighed over a ton, and the conveyance of these up a steep incline to our observatory plateau, we had to erect a dwelling for the observers, with storehouse and bakehouse, and to put together the separate observing huts for transit and altazimuth, equatoreal and photoheliograph.* Each instrument required a very solid foundation, so we dug down to the solid rock, levelled as far as necessary with concrete, built a brick pier to the most convenient height, and then cemented the stone of the instrument upon it. A similar pier had also to be erected for our magnetic instruments. For meteorology less preparation was required, but we were a little delayed by being obliged to replace the thermometer screen which had been destroyed in the last storm at sea.

When the buildings and piers were ready, the instruments had to be unpacked and put together, and examined in every detail, and small alterations made where necessary. Fortunately we found that no serious injury had been sustained by the delicate portions of the instruments, and we escaped with the loss of a barometer, some thermometers, a spirit-level, the spider-lines of a telescope, and a few other minor details. As each telescope was mounted it was brought at once into active service, and by the beginning of November everything was in full working order. At night one observer was at the transit instrument, watching the passage of stars across the meridian, and thus determining the precise error of our standard clock, and its daily rate of change. It was of the utmost importance to study for a considerable time the comportment of both instrument and clock, in order to discover if either had any irregularity that could be corrected; for it was necessary to feel confident that we could depend on our time to within the tenth of a second. Another observer was stationed each night at the altazimuth, a beautiful instrument, specially designed by Sir G. B. Airy for this expedition, and capable by star observation of determining the latitude to within a few yards. On nights when the moon was visible the telescope of the altazimuth was frequently directed towards it, and lunar altitudes or azimuths taken, from which the longitude could be calculated. At the transit instrument the moon's meridian passage was most jealously watched, for the same purpose as that for which the lunar observations were made with the altazimuth.

During the day the work of the night was computed, and the calculations carried on as far as it was necessary for the purpose of determining the error and rate of our standard clock, and of securing the perfect working of the instruments. Then we had daily practice with the prepared model of the transit of Venus, observing the contacts, measuring the separation of the cusps of the limb, and taking distances between the sun and Venus, as the dark round disc was carried by clockwork across its bright background, which represented the sun. A familiarity with the use of micrometer and telescope was thus acquired, and all doubt removed of the performance of the instrument or the skill of the observer. With the photoheliograph the sun's picture was taken several times on every favourable day, with the object of training the observers, of finding the best focus of the telescope, of testing its mounting, and of making certain that the sensitized plates were

well prepared. Several hours a day were also spent in preparing the dry plates that were to be used for sun pictures on the day of the transit. A daily comparison of each clock and chronometer with our standard clock, and a calculation of the error and rate of each was also required, so that no instrument might be used on the 8th of December that was not thoroughly known. Occasional practice with a spectroscope, adapted to a 4-in. equatorial, to be used at external contact, completed the programme of our daily astronomical work. As for magnetic observations, we could scarcely spare any time for these during the month of preparation for the transit, as we did not wish to undertake anything that might in the least interfere with our astronomical duties, and we hoped to find ample opportunities afterwards for the study of terrestrial magnetism. Meteorology did not present the same difficulties as magnetism, for the observations could all be made by the corporal and privates of the Royal Engineers, who devoted themselves to this with a zeal that never flagged. From the Cape to Kerguelen a series of meteorological observations was taken, until the storm of the 6th of October destroyed the thermometers, of which however we fortunately possessed duplicates. The meteorological office, under the charge of Mr. R. Scott, had liberally provided us with all things necessary for a complete observatory—barometers and aneroids, dry and wet thermometers with screen, maximum and minimum thermometers with screen, a maximum for the sun, a minimum for the grass, sea thermometers, and four earth thermometers to be buried at the depths of one, two, three, and four feet respectively, with an anemometer for recording the velocity of the wind, and a rain gauge. A tide gauge erected by the *Volage* was also read on shore. Observations were taken every two hours, day and night, during our stay on the island, and the care with which the work was done reflects the greatest credit on the men employed, who never complained of this heavy addition to their daily labours, but did it cheerfully and well.

During the progress of our preparations we were a little impeded by the heavy gales and frequent falls of snow, but towards the end of October the weather became somewhat milder. On the 25th of this month the early risers were rewarded by a sight, curious from its rarity. Snow had fallen for a short time and in very large flakes, and as the sea was at the time perfectly calm, and at a low temperature, the snow rested on the water to the depth of at least half an inch, and remained there for

good part of an hour. The inclemency of the weather did not deter those officers who were not required for active service on board or on shore from making frequent excursions in the neighbourhood of our observatory to explore the resources and products of the island. The strangeness and wildness of the scenery, which presents a dreary sameness of hill and bog and lake, without a tree or shrub to vary the monotony of the landscape, would scarcely have secured an oft-repeated visit, had not the full game bags each evening been a temptation not easy to put aside with the prospect of a long sojourn in a desert island. The reports we had heard of the abundance of wild duck were proved not to be a mere imagination, and though somewhat small in size, the birds were pronounced on all hands to be equal in flavour to anything of the sort in Europe. Nor were these the only welcome gifts that our newly adopted country provided spontaneously. Everywhere we found an abundant supply of the plant known as Kerguelen cabbage, which, when carefully boiled in several changes of water, lost all its bitterness, and became a general favourite at the dinner table. Penguin soup was by some considered very good as a change, having much the same flavour and appearance as hare-soup ; but the Penguin steaks were scarcely a success, the black, hard flesh being anything but inviting. The eggs, too, were good, and made palatable omelets, though their greenish colour was decidedly against them. As soon as the preparations at our principal station were sufficiently advanced, we began to think of establishing our second station for observations, and on the 27th of October an expedition was organized for attempting a second time the exploration of the country about Swain's Haulover, a narrow neck of land separating Royal Sound from Swain's Bay. On this trip we used H.M.S. *Supply* instead of the steam-launch, and assured ourselves before our return that there were several spots well suited for our purpose, though very inferior, as a primary station, to that which we already occupied.

As yet, time had not allowed us to pay an official visit to our American friends at Molloy Point, near the north entrance of the Sound, and all that we had seen of them so far was the hurried visit paid by the officers who brought their letters from the Cape. Not being supplied with a convenient boat, they were unable to travel so far as Observatory Bay, so it became a duty to call on them as soon as possible. A couple of hours of careful navigation brought the *Supply* in sight of the American

station, and Captain Ryan, U.S.N., had hoisted the stars and stripes on his flagstaff, and hastened down to the beach to welcome us, before we had lowered a boat to reach the shore. The Americans were stationed on the side of a hill facing east, their instruments being placed at considerable differences of elevation on account of the slope of the ground. Their supply of water was excellent, and the wild duck even more numerous than in our neighbourhood. Their instruments consisted of a transit, a photoheliograph, and an equatoreal, established in separate huts at a distance from their dwelling, and there was an air of comfort and cheerfulness about their establishment, due in part to the numerous fowls to be seen running about in every direction. Our reception was hearty, and after we had spent some time examining their instruments and other objects of interest, they, at the request of Captain Fairfax, accompanied us to the *Supply*, and spent the evening with us at Observatory Bay. The next morning arrangements were made for longitude signals on Muscle Island, which could be observed simultaneously by Americans and English, and then our friends departed, and the *Supply*, after touching at Molloy Point, carried a detachment of the British astronomers to the site chosen a few days previously for our second station of observation.

Lieut. C. Corbet and Lieut. G. E. Coke, R.N., were to occupy this post, assisted by Sub.-Lieut. Baines and Mr. Dorrien, midshipman, R.N. Their instruments consisted of a transit for time observations, a small altazimuth for the latitude, and two 4-in. telescopes, mounted on tripods, for watching the passage of Venus across the sun's disc. A good clock, some chronometers, and the necessary meteorological instruments, completed their scientific equipment. No time was lost by officers or men, and on the 12th of November the dwelling and observatory were erected, the brick piers built, stores landed, and all necessary arrangements completed, and H.M.S. *Supply* returned to Observatory Bay. The departure of the vessel proved unfortunate in the sequel, though the difficulty which arose could not have been foreseen. On the very evening of the ship's return to our principal station, the observer at the transit instrument, which had just been erected, had the misfortune to break the spider-lines over which the passage of stars is observed, and this accident, slight though it may appear, rendered the telescope useless. As the spiders that spin geometrical webs happen to be unknown in Kerguelen, and the spider-lines taken out from England were all

at the principal station, it was necessary to undertake a journey overland from Swain's Haulover to Observatory Bay in order to get the damage repaired. Lieut. E. Coke and Sub.-Lieut. Baines started at once on this errand, and though the direct distance can scarcely be more than six good miles, the expedition nearly cost them their lives. They left Swain's Haulover about mid-day, and night came on before they had passed the second of the three inlets which separate the two stations. Their difficulties arose partly from the nature of the ground, which consists either of rough hills, covered often with loose stones, or of soft, boggy land, into which they were continually in danger of sinking up to the knees, and partly from the inlets of the sea, which run in every direction into the land, often to the distance of ten or twelve miles. The two officers had walked round one of these long arms of the sea, when they were overtaken by the darkness, and prevented attempting the second before night. In the absence of daylight it would have been too dangerous, and almost impossible, to advance, so they sat down side by side, cold and hungry, with the prospect of still harder work on the morrow. Having scarcely any food, and thinking it hopeless to attempt to walk round all the inlets, they determined at day-break to swim across the water. The temperature was scarcely above freezing-point, but there was little choice left. Fortunately the water was not deep at the point where they made their first attempt, and they were able to wade safely across. But the second trial was more serious, as they had to swim nearly a quarter of a mile, and to pull themselves through the kelp, wherever this strong sea-weed made all attempt at swimming abortive. Both had strength enough to gain the shore, and afterwards reach our dwelling, though they arrived completely exhausted from cold, fatigue, and hunger. A good sleep, and the best food we could procure, had put all to rights by the next day, when they started again for Swain's Haulover in the steam pinnacle of the *Volage*.

This trip of the steam pinnacle served another purpose as well as that of conveying back the two officers with their dearly bought spider-lines, for it was necessary for the chiefs of the expedition to hold a final consultation about the disposition of the observers on the day of the transit, which was drawing very near. It had been proposed to occupy, if possible, Heard Island, as well as Observatory Bay, and Swain's Haulover, and every inquiry had been made of Captain Bailey and others

about the practicability of the scheme. Now that the Americans had not occupied the Crozets, and that all the Kerguelen observatories, American, German, and English, were in or near Royal Sound, one large cloud might easily extinguish all our hopes. A station a few hundred miles to the south-east would strengthen our position wonderfully, and even if the most perfect chronometer connection could not be made between Kerguelen and Heard Island, the latter might still serve as a first class Halleyan station, independently of its longitude. Both Germans and Americans had at first expressed their intention of establishing themselves on Heard Island, and it was only after the reports of H.M.S. *Challenger* that we learnt that they preferred settling down near our station in Kerguelen. An important spot was therefore deserted, and we determined, if possible, to occupy it ourselves, without weakening materially our principal stations. The reports of the *Challenger*, combined with what we had already learnt from the sealers, had not as yet forced us to renounce our project, and Captain Fairfax was still holding H.M.S. *Volage* in readiness to make the trip to Heard. We had been for some time anxiously awaiting the arrival of Captain Fuller in the *Roswell King*, who is considered the highest authority on any question connected with these islands. He had just arrived at Swain's Bay, and had an interview with the observers of the second station. His report of Heard was even less favourable than those of the other sealers. It appears that there is only one spot where a landing can be effected even in good weather, and that there both observers and instruments would have to be conveyed on shore in the small whaling boats of the sealers, the surf rendering the use of the ship's boats out of the question. The chances too of a fine day were very small, indeed there were few days on which it would be possible to land at all. With such a prospect before us it would have been scarcely prudent to have sent the *Volage* to sea, to expend the valuable supply of coal, which we were sure to need so much in the calms of the tropics on our return, and to expose her crew to all the hardships of gales such as we had already experienced off Kerguelen. Had there been fair hopes of success, Captain Fairfax would have made the venture, and Lieut. E. Coke had generously volunteered to conduct the observations, but under the circumstances nothing remained to be done but to settle upon some other site for our third station.

During our stay at Kerguelen the naturalist, the Rev. A. E.

Eaton, had spent his time wandering among the hills, and had noticed that the sun was not equally generous to all parts of the island, and that the country around Thumb Peak, in the south-east portion of Royal Sound, met with special favour. It was resolved therefore to replace Heard Island by Thumb Peak, and Lieut. Goodridge, one of the staff of astronomers at Observatory Bay, was selected for this station; Mr. Eaton, who had kindly volunteered his services, assisting him as time-keeper.

According to our instructions from the Admiralty, we had to look for assistance on the day of the transit to the naval officers of the two vessels forming part of the expedition. As we were unprovided with chronographs this help became absolutely necessary, for it would be impossible for the observer at the telescope to remove his eye for an instant during the time immediately preceding or following the internal contacts of the planet with the sun's disc without risking the loss of the most important phase. Both Captain Fairfax and Captain Inglis set the excellent example of volunteering for this service, and there was no difficulty in completing the required number.

As the eventful day drew nearer, the preparations became more and more active. Each morning soon after sunrise all the instruments were pointed in the direction they were to assume at the same hour on December 8th, in order to make certain that nothing might be unforeseen, that no clock or other fixed object might be in the observer's way, and that no instrument worked badly in the required position. The officers who had volunteered to help in the observations came almost daily on shore to practise with the model transit, and to familiarize themselves with the duties assigned to each. Two days before the transit, H.M.S. *Supply* left Observatory Bay to establish Lieut. Goodridge and the Rev. A. E. Eaton at Thumb Peak. They found an excellent site overlooking the sea, and, aided by Captain Inglis, erected a temporary shelter for their telescope as a protection against high winds. The legs of the instrument were also fastened with molten lead, in holes cut in the solid rock, to secure all possible freedom from vibration.

On the eve of the transit everything was in complete readiness at all three stations, and the following was the plan of observations finally agreed upon as best carrying out the views of Sir G. B. Airy, and utilizing to the utmost all the means at our disposal. At Thumb Peak, Lieut. Goodridge, with a

4-inch telescope and assisted by the Rev. A. E. Eaton was to observe the contacts at the ingress and egress of the planet: at Swain's Haulover, Lieut. Corbet, with a 4-inch telescope and assisted by Sub.-Lieut. Baines, and Lieut. Coke with a $3\frac{3}{4}$ -inch telescope and assisted by Mr. Dorrien, mid. R.N., were to take observations similar to those at Thumb Peak; and at Observatory Bay, the same was to be done by the Rev. W. Sidgreaves, with the Sheepshanks' 4-inch equatoreal, and assisted by Nav.-Lieut. Fenn. This series of observations at the three stations was the more valuable on account of the similarity of the instruments, all of which had nearly the same aperture. Besides these similar observations three other series were to be carried on at Observatory Bay. Captain H. Fairfax, the Rev. J. Budds, and Lieut. Dowding, R.M., assisted by Mr. Carden, mid. R.N., were to take independent observations of the contacts at ingress and egress, all watching the same magnified image of the sun projected on a white screen by the Jones' 4-inch equatoreal. The Rev. S. J. Perry, assisted by Lieut. Gamble, R.N., was to observe the contacts at ingress and egress with a 6-inch equatoreal, to measure frequently the distance between the cusps before internal contact at ingress, and after it at egress, and also the distance between Venus and the sun's limb whilst the planet was on the disc and very near the edge, and at other times to obtain a series of values of the planet's diameter with a double image micrometer. At the photoheliograph the work was much heavier, but it was shared by several. Previously to the commencement of the transit several pictures of the sun were to be taken by Mr. J. B. Smith, assisted by Corporal Wright and Sapper Wilson. A negative of the reticule in the eye-piece was also required as a test for shrinkage of film, and a double negative of the sun to determine the position of the wires of the telescope. Just before the first external contact, of which notice was to be given by the observer at the spectroscope, the sun was to be photographed every second, by aid of a Janssen plate, during the space of one minute, and then photographs were required only every two minutes until Venus approached internal contact. Three minutes before this contact a second Janssen plate of fifty pictures was to be exposed, followed by a third which was to include the contact, and a fourth immediately afterwards. The second and fourth Janssen plates were strongly recommended by the Admiralty Astronomer at the Cape of Good Hope, Mr. E. J. Stone, as

the second would afford the means of measuring afterwards the distances of the cusps, and the fourth the distances of the limbs of Venus and the sun, in close proximity to the most important instant. These Jänssen plates were to be followed by ordinary solar negatives taken every two minutes during the four hours between internal contact at ingress and egress, with an occasional picture of the reticule, and a position-of-wires negative. At egress the photographs were to be precisely the same as at ingress, but the order of the phenomena would of course be inverted.

During the whole time of the transit the process of developing the plates was to be carried on in the dark room. Sapper Hilbert, an experienced photographer, had the sole charge of this important duty, with the exception of two half-hours, when the Rev. S. J. Perry was to replace him. Dry plate photography having been preferred to wet, it was only necessary at the time to develop sufficient plates for making certain that everything was working well; the rest of the plates could safely be developed later.

A large direct vision spectroscope was made by Mr. Browning expressly for the observation of Venus on the chromosphere, by aid of which external contact might be satisfactorily obtained at ingress, and notice given to the photographers and others of the near approach of the planet. The instrument was confided to the Rev. W. Sidgreaves. Such was our proposed plan of operations, and we retired to rest with the hope of a rich and plenteous harvest on the following morning.

III.

THE night between December 8th and December 9th—December 8th by astronomical reckoning, as astronomers begin their day when the sun culminates on the meridian—was an anxious time for many, and the observers knew that their anxiety was shared by others, who, though far away from the scene of excitement, still took a deep and lively interest in the success of friends who had gone so far in hopes of witnessing the transit. A cool head and a refreshed body are among the conditions requisite for a perfect observation, most, therefore, of the Kerguelen astronomers retired early to rest, though some had little hopes of sleep. The opening of December had brought us fine mornings, but starless nights,

so that our standard clock, though going excellently, was yet in some need of a few star observations for verification. The night of December 8th was fortunately most propitious, and the observer at the transit instrument procured a double series of star passages across the meridian, which gave us most accurately the error and rate required.

The sun rose with fair promise of success, and by four o'clock all the observers were on the alert, and in high spirits at the proximate realization of their long deferred hopes. There were two hours and more before the predicted time of first contact, but much had to be done by way of preparation. Towards half-past four the roofs of the observing huts were beginning to be removed, the instruments to be brought into position, the eye-pieces, and dark glasses, and solar prisms, and micrometers, all cleaned and arranged, with note books, and pencils, and everything that could be thought of as likely to be required. In the photoheliograph the utmost attention was paid to order and cleanliness, as the least false step might otherwise have thrown the numerous array of plates into hopeless confusion. Every clock or chronometer to be used during the observations, was then carefully compared twice with the standard clock. The morning remained fine, but the sky was not the clear blue of the Italian heavens, nor yet that of a good summer's day in England. There were fleecy clouds, and sufficient haze to prevent any successful work with the spectroscope, so that it would have been imprudent to waste any precious time upon this instrument. We determined therefore to confine our attention entirely to the telescopes and photography.

At six o'clock, Captain Fairfax landed with the officers of the *Volage*, who were to take part in the observations; and several quarter-masters also came on shore to station themselves as sentinels and messengers at the different huts and instruments. The first persons actually at work on the sun were the photographers, who wanted their negatives of wires and reticule, and who had great need of trial pictures on account of the haze. As half-past six o'clock drew near all were standing at their posts, and we soon had the certainty of knowing that Venus was entering on the sun's surface, for a dark body, round and well-defined, was seen advancing steadily across the edge of the solar disc. The first external contact could of course only be obtained with a rough degree of approximation, as the obscure planet must already have eaten its way considerably

into the bright body of the sun before it could be perceived without the aid of a spectroscope. The sun's light was never very brilliant, and our first disappointment was the news that Captain Fairfax and the officers with him were unable to obtain a sufficiently clear image for observation, and that the photographs of the sun were extremely faint. With the other telescopes, however, it was easy to follow the progress of the planet, and to note the approximate time when the centre of Venus was passing the sun's limb. A little later we began to feel somewhat nervous, as a dense cloud, not very large in extent, had made its appearance, and was travelling slowly but steadily in the direction of the sun. When the latter became at last completely eclipsed by the cloud, we were delighted to find that it wanted several minutes to the most important instant of internal contact. We hoped that there would be ample time for the small cloud to pass off. We waited, uneasy but not discouraged. The slightest breeze would have saved us, but the wind, usually so extravagant in its generosity to the Kerguelen hills, was now silent and niggardly, and the dreaded cloud seemed to settle down, as if in its destined place, and there remained covering the sun for fully twenty minutes. When we next saw the sun, Venus was well advanced on to the solar surface. It is needless to attempt to picture the disappointment of observers, and officers, and men. Those who had only contact observations to make discussed their griefs at the breakfast table, and hoped for better things at the planet's egress, though they all felt intensely the want of success at the most important moment.

The observers at the photoheliograph, and those who had to take measures with the double image micrometer, remained constantly at their instruments, watching every change in the clouds that could give any chance of useful work. Besides approximate external contact and bisection, we were enabled to obtain thirteen photographs of Venus on the sun's disc, and about the same number of measures of distance of limbs, besides several determinations of the diameter of the planet. Occasionally the sun's light was strong enough to penetrate the double-image micrometer, and at rare intervals we were even able to see the sun and planet through a thin dark wedge, but generally we could only succeed in tracing the two circles, even with the 6-inch equatoreal, when using an ordinary eye-piece without any dark glass.

As egress approached, the sun cleared a little, without being ever brilliant. We managed, however, to secure both internal and external contact, as well as bisection, with the 6-inch and 4-inch equatoreals. Of the more delicate features of the picture none were visible at our station, no change of form in the planet, no rim of subdued light due to the atmosphere of Venus. We saw only the simple internal geometrical contact of the smaller circle with the larger, and then the disappearance of the one from the other. When all was over, the equatoreal sidereal clock and the chronometers were again twice compared with the standard clock. Considering the climate we had expected to find at Kerguelen our success so far was moderate, and if supplemented by observations at the other stations might still give fair results.

The *Supply* was to return the same evening with the observers from Thumb Peak, and when we heard their report we had good reason to congratulate ourselves on the results of the day's campaign. Lieut. Goodridge had been most fortunate; no envious cloud had veiled the beauty of the goddess whom he had travelled so far to behold, and he had the satisfaction of watching every phase of the transit from external contact at ingress until the final departure of Venus, though the clouds at egress were somewhat troublesome. Both Goodridge and Eaton had spent the night of December 8th on shore in a tent, for fear lest a rising wind might have forced the *Supply* to leave her anchorage. Snow fell during the night, and the early morning was rather cloudy, but the sun cleared before Venus had reached his disc. As the planet approached internal contact at ingress, its external limb was made visible by a faint rim of light, and after geometrical contact there was a gradual but rapid increase of light between the planet and the sun's edge until the intensity became equal to that of the remainder of the surface. The absence of all deformation, or drawing out of the planet, as it advanced wholly on the sun, was very marked. At egress the light was but faint, yet the diminution of the light between Venus and the sun's edge, the internal contact, and the final departure, were all timed with fair exactness.

The badness of the weather prevented any communication with Swain's Haulover until three days after the transit, but then we learnt that the observers at this station had been completely successful at ingress, but failed at egress.

Lieutenants Corbet and Coke both observed the same phenomena, but the former had a telescope with a slightly larger aperture, better mounted, and also supplied with a solar prism. The image of Venus on the sun seems to have been steadier here than at Thumb Peak, and the results will in consequence be probably more exact. External contact and bisection were obtained with a fair degree of approximation, and internal contact was all that could be desired. Previous to this important phase the small rim of faint light, which was seen at Thumb Peak, was observed here, causing the edge of Venus, which was still off the sun, to be visible several minutes before contact. As the planet advanced this rim of light was observed in perfect contact with the sun's limb, and then both the slight shade in the track of Venus, and the faint light around her, disappeared rapidly together. The bright edge of Venus was described by Lieutenant Corbet as "a cold brownish white light, as steady as possible, with black speckles here and there, like irregularities on the planet's surface." * Every remark connected with this appearance is of value, not merely as completing the record of a rare physical phenomenon, but as affording the true means of accurately determining the precise instant of internal contact.

We are now in a position to take in at a glance the complete results obtained on December 8th, at our three Kerguelen stations. Of the two external contacts, the first, which from the very nature of the observation can only be a rough approximation without the aid of the spectroscope, was observed by several, and the second accurately timed by three observers. Both internal contacts were well observed by three persons, and fortunately the most important observation was also that which was best observed. The time was also taken when the centre of the planet was on the sun's limb, and though this cannot compare in accuracy with the contacts generally, it might, when estimated by a practised observer, fairly be preferred to the first external contact. Besides contacts and bisections, we obtained thirteen photographs of Venus on the sun, seven of which may be of value, and about an equal number of micrometric measurements of the distance between the limbs, with also a few diameters of the planet. We have, therefore, data sufficient for the application for the methods of both Halley and Delisle, and also for the photographic or direct method.

The observations made of the bright outer limb of Venus, some time previous to internal contact at ingress, afford evidence of the existence of a planetary atmosphere capable of refracting the solar rays in quantity sufficient to be distinctly visible even through a coloured wedge, and it is a matter of great importance that Lieut. Corbet was able distinctly to note the instant when this atmosphere of Venus was tangent to the solar limb. The absence of any distinct approach at internal contact to an elongation of the planet in the direction of the point of contact, or to what has so often been spoken of as the "Black drop," is very noticeable; the only phenomenon that bore the least resemblance to it being the slight dark shade that for some seconds obscured the point where the cusps had just met in rear of the planet. We were naturally desirous of learning what would have been our fate had we persevered in our intention of establishing a station at Heard Island. The sealing schooners, which left Royal Sound towards the beginning of October, returned to Kerguelen after their annual visit to the more southern island, and we learnt from the sealers the news of December 8th. At Heard, the sun had shown himself on the morning of the transit, but not at or near Whisky Bay, the only landing-place of the island. The weather too had been very rough for many days, both before and after the 8th, so that it would have been impossible to have got on shore to prepare for the observations, or to have re-embarked the observers for a considerable time, unless they had completed their work on the day itself. We were thankful, therefore, that we had not attempted the ungrateful task of manning Heard, but it was still a comfort that every reasonable effort had been made to secure this valuable post, until all chance of success appeared hopeless.

All the observations of the transit had now been taken, and some thought that it only remained to dismount the instruments, pull down the observatories, and return with all despatch to more genial climes. This was perhaps the desire of all, certainly of most, and it was doubtless with some surprise, and not a little chagrin, that many learnt that the greater part of our heavy work had yet to be done. The all absorbing thought of preparing for the coming transit had mainly occupied our minds during the six weeks that preceded December 8th, but we had never lost sight of the simple though weighty instruction of Sir G. B. Airy, that "the utmost attention must be given to the

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determination of absolute longitude, which will probably be fundamental for those seas." An excellent run had been made with eight chronometers from the Cape to Kerguelen on our voyage out, and we had already determined by gunpowder flashes the difference of local time between the English observatories at Observatory Bay and Swain's Haulover, and the American station at Molloy Point. Besides this, chronometer runs between the Cape and Kerguelen had been made by the *Swatara*, U.S.N., and H.M.S. *Challenger*, and the German war-frigate *Gazelle* had compared chronometers with our standard clock on the occasion of her visit. But when longitudes are required correct to a second of time much more than ordinary care must be taken. Our only hope of a sufficiently accurate longitude was from observations of the moon, and so far she had proved herself very disappointing. Night after night we had watched from sunset to sunrise, whenever she was above the horizon, in hopes of getting a glimpse of her, and fixing her position. One hundred double observations of lunar altitude or azimuth, and thirty transits over the meridian, were the numbers required, and our first two lunations had only given us about five transits and a proportionate number of azimuths. The prospect was not encouraging, and there was no excitement now to carry us through the work. But the line of duty was clearly marked out, and if it might not be possible to obtain all the observations, we ought at least to stay as long as prudence would permit. Calculations were made on both sides, the question of provisions was weighed against that of lunar observations, and the balance struck was that observations might be continued until the end of February, even though it were necessary to put all upon half rations. More could scarcely be expected, and we settled down to our twelve weeks' work with the pleasant prospect of a home journey of many thousand miles upon a scant allowance of even the necessities of life. To be a martyr for science is all very well in contemplation, but all may not find it quite so agreeable in the practice. We must not deny that there was a little grumbling, 'tis an Englishman's birthright, but the work was done, and we hope thoroughly.

Whilst the slow and laborious process of collecting lunar observations was being carried on uninterruptedly at Observatory Bay, there was other work to be done in the vicinity. The duty of connecting all the Kerguelen stations by chronometer had

been confided to Lieut. Corbet, and now that the transit was over he could devote himself entirely to this important task. The stations to be visited were Swain's Haulover, Thumb Peak, Molloy Point, and Betsy Cove. The first three would not force the *Volage* to leave Royal Sound ; but for a visit to the German station at Betsy Cove it was necessary to expose the vessel for two days in the open sea. It was resolved, therefore, to undertake two runs to places within the Sound, and, as the Germans had already compared chronometers with us, to confine ourselves to a single comparison with them.

At all the stations observations for determining local time had been carried on for several weeks, with the sole exception of Thumb Peak, where time had been obtained on the day of the transit from chronometers compared before and after with the standard clock at Observatory Bay. It was therefore necessary to establish a station at Thumb Peak for a few days, in order to determine accurately the latitude and local time of the place previous to the arrival of the *Volage* with the longitude chronometers. Sub.-Lieut. Baines very kindly volunteered to accompany the Rev. S. J. Perry to this spot, and to live there in tents during the observations. It was then near midsummer in the southern hemisphere, and the latitude being less than 50°, a few days under canvas might appear no great hardship. H.M.S. *Supply* went round with us to our new observatory, and Captain Inglis did all in his power to settle us comfortably on shore. The circle of stones, that served as a rough protection to the observing telescope on December 8th, was raised higher and made more firm, a brick pier was built in its centre for the Delarue altazimuth, which had been brought from Swain's Haulover, and arrangements were made for the three chronometers, aneroid, thermometer, and collimator, which completed our small observatory. Two tents were pitched within a few yards of the instrument, and with some spare planks we extemporized a kitchen. The night was spent on shore, and the next morning, finding that we had all that was requisite, the *Supply* returned at once to Swain's Haulover to convey Lieut. Corbet to his chronometers on board the *Volage*. At Thumb Peak our duties were very simple, and simply divided. Nash, gunner's mate of the *Supply*, and Passingham, a boatswain's mate from the *Volage*, relieved us from all care of household arrangements, and the gun of Mr. Baines supplied us abundantly with fresh game for the table. The wild ducks were so plentiful in this

place, that we were able to lay by a store for our friends on board, who had long since driven most of the birds away from the neighbourhood of Observatory Bay. As often as there was any probability of a break in the clouds, the stars were watched during the whole night, and at every opportunity observations were taken for latitude, or local time, or for instrumental corrections. For a few days the weather was passable, but then we were visited by heavy rains and strong winds, till we expected every moment that our tents would be blown entirely away. But the gunner's mate managed these excellently, and they not only stood firm, but kept out the wet perfectly. A heavy fall of snow, which stood deep on the ground, next tried our defences, and we were glad to take refuge in our seal-skins and furs. Our friends at a distance could see our mountain covered with snow, and Captain Fairfax began to get anxious about us, and visited us earlier than he had at first intended.

A single day sufficed for the first chronometer run from Observatory Bay to Molloy Point, and thence to Thumb Peak, and Swain's Haulover, and back again to the starting-point. A few days later Thumb Peak and Molloy Point alone were visited, Swain's Haulover being reserved for a special day, as the secondary stations were to be abandoned immediately after the final chronometer comparisons. This portion of our work was completed, as far as Royal Sound was concerned, on Christmas eve, and we waited for a fine day to pay a visit to the Germans.

Christmas was of course spent in the good old English style, and our only bullock contributed, perhaps unwillingly, his full share to the festivities. All our cattle save this one had been killed in the last storm, or had died since, but a good number of our sheep were still alive, though they were mere skeletons when landed on the island. The grass was not plentiful, yet these animals managed to find food sufficient to tempt us by their improved appearance. On our journey to Kerguelen the mutton had become insipid, and as the ducks were abundant, and we were not yet tired of preserved meats, the sheep remained for a time unmolested. When, however, the ducks became more scarce, and we wished to try our mutton, we found to our cost that the sheep had tasted a liberty they were very loath to sacrifice. Many attempts were made to drive them home, but the animals wisely kept to the hill-tops, where pursuit became very difficult. We were finally obliged to take to sheep

stalking, and after all had been fairly tired out, the most persevering of the officers had the good fortune to get within easy shot of an animal. This proved to be in such excellent condition that the number of sportsmen was largely increased on the following day, and their labours were again rewarded, for the only chance of the day, a flying shot with a rifle at three hundred yards, was not allowed to escape. Unfortunately these were our only successful days, though the sport was kept up with spirit for several weeks, and the remainder of the sheep, if not dead of cold, may still be enjoying their freedom on the Kerguelen hills.

The scarcity of wild ducks in the immediate vicinity of our station forced the officers of the *Volage* and *Supply* to organize shooting expeditions in boats, and these trips became occasionally somewhat exciting. On one occasion a few had gone in the lifeboat a mile or two in the direction of Swain's Bay, when a rather strong breeze sprung up suddenly, and prevented their return by sea. A walk was the only alternative, and when Observatory Bay was reached, all were so exhausted that no one had strength left to raise a shout for help. On another day, a sudden squall upset the boat in an instant, and the only chance of safety was a scramble on to the keel, where all held on as best they could. The boat, keel uppermost, drifted towards the open sound, only two islands being in the direction of their course. The nearest was a large island, which the current carried them round, but they managed to make the smaller island, and all landed in safety. It was quite impossible for them to right their boat, and when night came on they had to try to keep warm in their wet clothes without food or fire. Their ship of course missed them in the evening, and they were rescued from their painful position on the following day.

On the evening of December 29th there was every promise of fair weather on the following day, so preparations were made for an early start on the morrow for the German station at Betsy Cove. The *Volage* was not long steaming out of Royal Sound; the sea was calm and the weather clear, and early in the afternoon we were already in sight of our destination. The German frigate, the *Gazelle*, was absent on a cruise to intercept some Australian clipper on its way to Melbourne, and thus send early news of success by telegram to Europe. A somewhat similar idea had suggested itself to the mind of our Astronomer Royal, and Messrs. Green and Co. had kindly taken charge of

two letters for Kerguelen, but, considering what we know of the weather near this island, it will not be matter for astonishment that these letters only reached the person to whom they were addressed as he was passing through Aden on his homeward journey.

As we neared the shore we were not a little surprised to see what appeared at first like a graveyard surrounding the buildings of the astronomers. The spot was most carefully scrutinized by our telescopes, and still no other satisfactory explanation could be suggested of what we saw. It was difficult to believe that the Germans had settled down for their half-year's work on the Island of Desolation, in the midst of a crowd of gravestones, but so it was. The site was good for observations, and the surroundings were accepted as an unsought embellishment. Betsy Cove had formerly been much frequented by the whalers and sealers, it being the last harbour to the north-east of the island. About 1840 the number of vessels employed in this trade at Kerguelen was from five to six hundred; it is now reduced to a brig and three schooners from America, and in two years it will probably be abandoned altogether, owing to the unwise and barbarous manner in which the trade is carried on. The habitual custom of the sealers is to await the arrival of the seals, who go on shore to breed, and then without distinction of sex or age to slaughter wholesale with clubs all that come within their reach. The carcasses are afterwards divided among the different vessels in proportion to the number of hands who have been engaged in the cruel massacre. The sea shore of Kerguelen is in consequence almost abandoned by the seals at present, and Heard Island is failing fast. Facts such as these could scarcely have been present to the mind of a late writer in the *Contemporary Review*, when he informed his readers that American sealers "have mended their ways, and are now, as we have seen, taking the lead in preservation;" and that "the crime (of English sealers) will bring its punishment with it, unless we mend our ways speedily, and condescend to take a lesson from our Yankee friends." On the weather side of Kerguelen seals are said still to abound, but we were told that it is impossible, owing to the badness of the weather, for sailing vessels often to visit those shores, though with a small steamer a handsome fortune might quickly be realized.

As soon as our German friends were aware of our approach

a boat was at once manned, and the leading naval officer at the observatory paid us a courteous visit; the rest of the party remained on shore to receive us, and showed us the greatest hospitality when we landed. The general arrangements at this station were excellent, and very comprehensive. The dwelling was a solid, square built, one storey house, whose main supports were massive beams, the whole bearing a strong resemblance to the lower deck of a large three-decker. The inside was roomy and commodious, and every attention had been paid to the comfort of the observers, even to the papering of the walls. Their chief astronomical instruments were a photoheliograph, an heliometer, an equatoreal, and a transit. They had also an altazimuth, but this was erected in such a position that it was obviously never intended for the determination of longitude by lunar altitudes and azimuths. Its probable use was for finding the latitude. A most interesting portion of their establishment was the magnetic observatory, in which magnets were permanently erected for recording by eye observation the hourly variations of the declination, and of the components of the earth's magnetic force. Pendulum experiments were also carried on regularly, and both the geologist and the botanist of the expedition had been indefatigable in exploring and collecting specimens for the natural history of this desert island. The officers on board the *Gazelle* had their share too of scientific work; for, after establishing the astronomers at Betsy Cove, they had spent the time preceding the transit of Venus in surveying the northern coast between Christmas Harbour and Betsy Cove. In the midst of these continuous and most useful labours they had not forgotten the good old customs of Fatherland, of which we were reminded by the lighting up of the Christmas tree after dinner, and we spent a most pleasant evening examining the curiosities they had collected at Kerguelen and during their journey from Europe. Contrary to expectations, the weather on December 8th had been more favourable at Betsy Cove than in Royal Sound, and Dr. Börgen obtained four complete series of measurements with his heliometer, besides some very good photographs. It is to be hoped that the contacts were equally successful. Comparisons were made by Lieut. Corbet between the local time at the German and English stations, by aid of the longitude chronometers of the *Volage*, and star transits were taken during the night to determine the correction to be applied for reducing the observations made at the two stations to a common standard.

The next morning we were again fortunate in having a very fine day, and after a pleasant sail, during which we saw thousands of penguins lining the shores, and here and there a splendid white albatross floating quietly on the waters, we returned without accident to Royal Sound. A final comparison of chronometers with our standard clock completed the work to be done in establishing our longitude, connexions.

IV.

THE return of the *Volage* from the German station at Betsy Cove brought us to the close of the year 1874, and we still had two months to spend in the Land of Desolation before we could hope to complete the observations we had undertaken. The results required at each of the Government stations differed but little, and yet there was a vast difference in the amount of necessary labour. At some places, where one cloudless night followed another in rapid succession, even the moon observations were a matter of mere ordinary routine; but when half a dozen momentary glimpses at one or other of the clock stars was the only fruit of sitting for several hours, or even for the greater part of the night, at the transit instrument, the snow often falling whilst the star was being observed, it required a strong sense of duty to keep steadily to the work.

Whilst the astronomers were collecting their data for the accurate determination of a fundamental longitude, the naturalist of the party, the Rev. A. E. Eaton, assisted by both officers and men, was actively employed in amassing the natural products of air and land and water. The outer borders of the Antarctic regions abound in sea-birds of every description, and the island of Kerguelen is far from offering any exception to the general rule. A vast island, ninety miles by forty-five, without a tree or shrub throughout its whole extent, would scarcely seem the most fitting spot for birds to breed in, but the absence of woods and trees is partly compensated by the solitude and security of the place. Some of the feathered tribe prefer, with the teal or wild duck, to deposit their eggs in nests built under the cover of the cabbage or tea-plant. Others are contented with an open spot, as the tern and molyhawk, who invariably by their cries and aggressive flight give timely notice of a near approach to their eggs or young. The molyhawk, or skua, is the fiercest of the birds met with in Kerguelen, and it often becomes really dangerous when an attempt is made to

rob its nest, swooping down continually to within a few feet of the head of the spoiler. Captain Fuller informed us that on such an occasion one of his men was severely wounded in the head by a blow from a skua, but we fortunately escaped any serious accident. These birds were nevertheless considered as public enemies, and treated with some severity, on account of their hostile demonstrations, and their unmistakeable propensity to forget the law of mine and thine. * It not unfrequently happened that officers, who had walked a long distance with a heavy gun, and expended a portion of their precious ammunition in shooting a duck, had their temper sorely tried by the sight of a skua swooping down on their bird almost before it had reached the ground, and carrying it far out of reach of its lawful owner. The marines and blue jackets, who had less opportunity of supplying their table with game than the officers, were still more unwilling to allow the molyhawks to indulge in their thievish propensities. On one occasion a marine, who had just shot a bird, had the mortification of seeing a molyhawk quietly carrying off the prey. The man, not wishing to resign his right without an effort, made a rush after the captor, and in his hurry shook his cap off his head. A second molyhawk was as sharp as the first, and the marine had the double loss to deplore of both cap and duck.

The petrels were equally numerous, and quite as interesting as the skuas, but less destructive. These birds burrow in the ground, and as we walked along, especially towards evening, the gentle cooing of the miners could be heard in every direction under our feet. There were eleven distinct species of petrels found during our stay, ranging in size from a small goose to a swallow. They are generally to be found in their holes during the day, and when dug out the hens are often sitting quietly near their nests, whilst the cocks stay in an adjoining passage. Their mode of defence is to spit out a quantity of very noisome matter, and their approach is easily detected at some distance by a strong and exceedingly disagreeable odour.

The beautiful white chionis are often seen, singly or in pairs, according to the season of the year, near the water's edge, and their strongly spotted eggs, are found among the rocks on the sea shore. Of their own accord some of these birds spent several weeks with us, walking about among our huts like tame pigeons, until to our great regret they met with an untimely fate.

Unlike the birds already mentioned, the shags, or cormo-

rants, live together in large numbers, choosing the sloping side of a rock for their rookery. The penguins, too, of whom we found three distinct species, viz., the king penguin, the tufted penguin, and the jackass, or common penguin, live in large communities, sometimes thousands together, and their eggs form a very substantial staple of food for the sealers in those parts. As you walk through their rookeries, situated on grassy slopes, these curious creatures will waddle to one side, or partly up the hill, just fast enough to get out of your way, but if sitting on their nests, will require a push before you can take their eggs. When anxious to escape from you, they throw themselves on their breasts, and use both legs and wings to propel their heavy carcasses. They were incapable of resistance when seized by the beak, and it was a not uncommon sight to see one of the men with a huge bird under each arm trudging off to join his comrades in the shore boat.

In the neighbourhood of Observatory Bay, the sooty albatrosses were not very numerous in comparison with the other birds, and the nearest habitat of the large wandering albatross was the Prince of Wales' Foreland, where large quantities were captured by the seamen of the *Monongahela*, U.S.N., during her stay at Molloy Point immediately after the transit. The nest of the sooty albatross was less easy to find than that of most of the other birds, and it was often very difficult of access, as the captain of the foretop of the *Volage* unfortunately discovered when too late, for his foot slipped on the rock, and he fell a distance of thirty feet, knocking a piece of bone more than an inch long into his skull. This first fall was followed by a rebound, which probably saved his life, as it shook out the piece of loose bone, which otherwise might have presented insurmountable difficulties to the surgeons on board. The hardy old tar soon recovered sufficiently from the fall to be conveyed to his ship, and then he would not allow any one to assist him over the side of the vessel, and gave the customary salute to his officer before being taken below.

The Kerguelen gull seems to differ in nothing from those met with elsewhere. The never failing regularity of its attendance at meal time was a useful model of punctuality ever ready to hand.

The riches of the animal kingdom will be quickly exhausted, as the only trophies of our five months' search were two small mice, which had probably escaped from some vessel, and become

acclimatized on the island. The species was evidently European, the only marked feature being the length and softness of the hair. At the suggestion of Captain Nares, R.N., an attempt was made by order of the Admiralty to stock the island with rabbits and goats. The rabbits were procured from Robben Island, the penal settlement of the Cape of Good Hope, and were safely conveyed to Kerguelen. Boxes containing from eight to sixteen were deposited in different localities, and though some certainly perished, those near the dwelling were multiplying rapidly, and appeared to be very comfortably established in the side of the hill, with an abundant supply of cabbage and tea-plant on every side. Their greatest enemies will probably be the molyhawks, one young rabbit having already been killed, and another attacked by these fierce birds, but it is unlikely that they will be exterminated, as the Crozets, which were stocked in a similar manner, are now quite overrun with these prolific animals. The goats, taken from the Cape, were unfortunately breeding fast during the journey to Kerguelen, and only one of the young ones could be preserved in the fearful gale off the coast. Before we left the island, two others had been born, and the mother, in her desire of making her young ones as comfortable as possible under the circumstances, had deposited them in what she probably considered an excellent bed. This was found afterwards to consist of feathers actually pertaining to two young albatrosses, who paid by their lives for their generous hospitality to strangers. The sheep, unwittingly left on the island, were taken there for other than breeding purposes, and must in consequence shortly die out. The only chance of propagation was to leave on shore the pet ram of the *Supply*. This funny little animal had so far lost all natural instinct by long sojourn on board his vessel, with his regime of tea and soup and tobacco, that he positively refused to touch all green food, and when left on shore for a change, leapt at once into the sea, and thus forced the boat to put back for him. We can scarcely wonder at his refusing to condescend to associate with ordinary vulgar sheep.

The study of insect life, of spiders and snails, of worms and wingless flies, would afford many results interesting to the entomologist in this land of desolation, as the specimens are numerous and peculiar. To the uninitiated the most striking peculiarity was the inability to fly in most of the insects of any considerable size.

Vegetable life was abundant, though not very varied. Besides the species of tea-plant, and the cabbage, and the azorella, which at a distance has the appearance of huge tufts of moss, there were many kinds of ferns and grasses, with mosses and fungi, and lichens. No tree or shrub was found on the island, and the Scotch and Austrian firs, taken out from England, suffered too much during the long voyage to retain vigour enough for the trying climate of Kerguelen. Seeds sown in the drained land near the dwelling-house gave better hopes of success, but our other occupations scarce left us sufficient time to devote to a proper care of our kitchen garden. The soil seemed good, but the strong winds, and the absence of a genial sun, except on rare occasions, must tell greatly against any but the hardiest vegetation.

The climate of Kerguelen, taken as a whole, was much milder and more supportable than we had been led to suppose. It is true that we were never free from the danger of a heavy fall of snow even at midsummer, and the wind seldom failed to blow fully half a gale in the course of forty-eight hours. Occasionally too the strength was so great that it became difficult to stand when exposed to its full violence, and on one occasion a large heavy shutter was torn off one of the observing huts, and carried to a distance of more than thirty yards. Yet there were days when the sun shone brightly, the thermometer standing at 60° Fahr. in the shade, and it was pleasant to saunter about leisurely without great coat and comforter. During the latter end of spring and the summer the temperature seldom fell much below freezing point, the mean being perhaps a little over 40°. From mist we were well protected by the mountains north and west, as Capt. Nares had forewarned us. Of rain we had at times a rather heavy and continuous fall, but between the third week of October and the middle of December there was such a lack of rain that the dust, raised by the high winds in our well drained grounds, became one of our greatest annoyances. The barometer was at first rather a puzzle, for the fine weather came as frequently with a low as with a high pressure, but we soon found that a moving barometer, rising or falling, was the surest sign of coming wind or storm, which invariably abated when the mercury attained a maximum or a minimum. Altogether we had very little to complain of in the weather, as, in spite of wind and cold, the bill of health was remarkably clean, an average of only two on the sick list out of

a numerous crew being a very low rate for any part of the world. Considerable anxiety was at first felt about the health of the seamen, and though our stay was much longer than had been previously anticipated, the precautions taken by Capt. Fairfax met with complete success. Boat racing, and football, and a paper hunt, to say nothing of duck shooting, and sheep stalking, were among our methods of securing healthy exercise, and the first lieutenant never seemed to find it difficult to keep the men from idleness. Before quitting the subject of meteorology, I must not omit to mention the fine display of *Aurora Australis* witnessed from midnight till two a.m. on Nov. 13th. The rays starting almost from the horizon rose to a height of about 45° , and extended from south to east. The brilliancy and length of the rays varied very much, but there was no great variety in the phenomenon, which consisted mainly of bright vertical rays. On only one or two other occasions did we observe even the faintest indication of an aurora.

The *Monongahela*, U.S.N., which had entered Royal Sound on the very day of the transit, had started at once the work of demolition, pulling down and taking on board all that was valuable at the astronomical station of Molloy Point. On January 11th she was ready to sail for the Cape of Good Hope, and the American astronomers came to bid us farewell. Their steam launch had been sent ten days previously to give us timely notice, we were therefore able to despatch to Europe a well filled letter-bag, and also duplicate copies of all the important observations we had secured since our arrival. The Americans had not received the same stringent instructions respecting the longitude as were thought necessary in the case of the English expedition, and consequently they were now able to return, although they had only secured five transits of the moon and one occultation. The run of the *Swatara* from the Cape to Kerguelen had also, it is true, given them a first approximation to their longitude, and the *Monongahela* now compared chronometers with our transit clock at Observatory Bay preparatory to her return voyage to the Cape. Next morning they were on their way homewards, and as there was nothing now to detain the English crew at the astronomical station, Capt. Fairfax judged it expedient to break the monotony of their long sojourn at Observatory Bay by a short change of scene. His intention was to spend a fortnight at Sprightly Bay, on the south coast of the island, where the

attractions of an active volcano, a magnificent glacier, with hot springs and mineral waters within easy distance, would have made the change very acceptable. The naturalist of our party joined this expedition, as did also Lieut. Goodridge, whose health had never been good, and who was now totally unfit for work. The *Volage* weighed anchor early in the morning of the 13th, and the weather being fine, with only a gentle breeze, the trip to Swain's Bay was exceedingly pleasant. On their way, however, from this place to Sprightly Bay, their progress was suddenly impeded by a sunken rock, which the vessel struck five or six times, destroying more than a hundred feet of the wooden keel, and several feet of the iron one. A head wind was fortunately blowing at the time, and they were proceeding very cautiously, at not more than five knots an hour, so that it was easy to get the vessel off the rock. The consequences might otherwise have been very serious, as the shores were exceedingly steep and difficult of access on that part of the island. This accident forced the ship to return to Swain's Bay, and thus unavoidably diminished considerably the interest of the trip. Whilst the vessel was being examined by the divers, and all damage repaired, the captain afforded every facility to the naturalist for the prosecution of his researches, and an extensive collection of rare seaweeds, a young whale, and some seals, were the trophies brought back to Observatory Bay. The sea about Kerguelen seems to be rich in its varieties of sea plants, but it is almost destitute of fish. Besides a few sea leopards, and sea elephants, a whale, and some porpoises, only single specimens of three or four species were seen. Limpets and mussels are there in abundance, and not unfrequently large quantities of mussel-shells are found high up among the rocks, where the sea birds have carried them. The freshwater lakes are even still less well provided with fish than the sea; not a single specimen was met with during our stay.

On February 1st the *Volage* returned to Royal Sound without obtaining more than a distant glimpse of the sharp mountain peaks around Sprightly Bay, which bear so striking a contrast to the flat-headed basaltic hills of the eastern coast. Our last lunation at Kerguelen was about to commence, and we had hopes that, like its immediate predecessors, it would furnish us with a good store of lunar observations. These were to be continued until the very morning of departure, but in the meantime many of the instruments could be dismantled and

packed, the huts pulled down, the stores shipped, and all made ready for instant departure when the longed for moment arrived. The *Supply* was to return to the Cape with the instruments and stores, and the *Volage* to proceed direct to Ceylon. Duplicates of our observations were sent on board the *Supply*, whilst the *Volage* carried the original manuscripts. The huts now began to disappear one by one. First the photographic observatory, with its dark room, then the equatoreal, and storehouse; next the altazimuth hut, and the observatory dwelling from Swain's Haulover. On the evening of February 26th, the only buildings standing were the dwelling, which was to be left for the benefit of the sealers, and the transit hut, which still covered the last instrument to be used on Kerguelen. About 5^h 30^m a.m. the moon passed the meridian, and before eight o'clock both vessels had weighed anchor, and were merrily steaming out of Observatory Bay on the loveliest morning we had witnessed since our arrival five months before. The moon, which had served us so hardly at first, had become somewhat more tractable, and her transit on the morning of our departure made up a total of nineteen meridian passages, which, with ninety double altitudes or azimuths, and one occultation, furnish the data for our fundamental longitude. The run from the Cape to Kerguelen with eight chronometers, and the longitude connections by gunpowder flashes and chronometers, along with the latitude observations, complete the work done by our expedition for the determination of the exact position of the group of Kerguelen stations. The identification of the localities, and the record of the relative positions of our several instruments also received their due share of attention. For besides the general description of the sites, and the accurate measure of the bearings of prominent land marks, a series of photographs were taken of the stations and surrounding views, a ground plan of the observatory was made by Sapper Hilbert, and surveys of Royal Sound were undertaken by Capt. Inglis and by Lieutenants Vivian and Fenn.

The view of Kerguelen as we neared the entrance to the Sound was truly magnificent, with its snow-covered mountains stretching out in the far distance, and each point of the wild landscape lit up with brilliant sunlight. When we had fairly cleared the Sound the *Supply* continued to hug the shore, but the *Volage* at once shaped her course due north. No sooner were we well out at sea than a sudden change came over the

scene. In lieu of the joyful sunshine we had run into the everlasting mists of the Southern Ocean, and for six or seven days we were never able to see more than a few hundred yards of the waters around us. The track of the Australian clippers had to be crossed at right angles, and there was a little anxiety on account of the denseness of the fog. One of the heavy guns on the port side was kept always ready loaded, to give instant notice to any vessel that might suddenly come in sight. This first week of our return journey was dismal enough, but we had at least the consolation of knowing that we were making good progress. At last we once again obtained a glimpse of the sun and sky, and determined our position by direct observation. We had passed a few hundred miles to the east of St. Paul's, where the French, under Capt. Mouchez, had been watching the transit, and we were now abreast of the central portion of Australia. A day or two of quiet, and then a fresh breeze, which became every hour stronger and stronger, made some think that we had met with the Trade winds more to the south than usual. We had not, however, long to wait before all doubts were put to rest, and every one was fully convinced that we were overtaken by a cyclone. It is well to have witnessed the grandest efforts of nature, but one cyclone is quite sufficient for a lifetime. The storm off Kerguelen had shown us the effects of a westerly gale in the vast Southern Ocean, where there is nothing to break the long waves which roll on from west to east, following each other at regular intervals, threatening each instant to engulf the vessel, and casting tons of water over her decks. But now much has changed. Instead of mist there are clouds as black as coal, huge broken waves replace the vast rollers, and the deafening roar of the wind among the rigging forbids any attempt at word of command. For nine-and-forty hours our captain and first lieutenant are unceasingly at the post of danger; no sleep, and scarcely any food. Another of our boats has been torn from its davits, and has to be cut adrift. The green waves pour freely over the hammock-nettings, carrying seamen bodily over the guns on deck. The men are unable to hold on at the wheel, and one, more vigorous than his mates, is twice carried round without relaxing his grasp. It is almost needless to say that we were flooded everywhere, the wind blowing a hurricane, and the ship rolling at times more than 45°. Each time that the side of the vessel went completely under water, there was a moment-

any doubt, in some minds at least, whether she could right herself, but the noble ship behaved gallantly and proved herself thoroughly seaworthy. From calculations made on board afterwards we passed within twenty-two miles of the centre of the cyclone, yet we lost no lives, and our chapter of accidents included only eight slightly wounded. Whilst the storm was at its height we lay to watching every sign that might indicate the direction in which the centre of the cyclone was travelling. and with steam ready for use at a moment's notice. The indications of wind and barometer were at last conclusive, and we steamed away from the dreaded storm, though it was some days before we were quite free from its influence.

Before arriving at Ceylon we met with no further incident; if we except the sudden death of the ship's steward, and the probably not consequent sight of two enormous sharks. Landing at Galle, it was a curious coincidence that we should meet at the hotel Captain McDonald, one of the two independent and almost simultaneous discoverers of Heard Island. From Galle we sailed to Bombay for provisions, thence to Aden, and through the Red Sea and Suez Canal to the Mediterranean.

When the *Volage* reached Galle six months and more had passed since letters had been received from Europe; we were therefore most anxious to read our news from home and to hear what had been going on in England. For many of us the next thought was about the success of the other expeditions sent out to observe the transit of Venus. At each port we found a heavy post with telegrams, and letters, and reports, and articles in abundance on the subject of the transit, and before reaching Europe we were able to form a fair notion of what had been achieved as a whole. It was natural to expect that the English papers would contain fuller reports of the work done at British stations than at those of other nations, but the printed evidence was abundant to show that in the total list of successful observers we might reckon a fair proportion of our own countrymen.

Of the five expeditions sent out from Greenwich one only failed, and Rodriguez and Egypt were remarkably successful. In India the Government astronomers, Col. Tennant and Capt. Campbell, as well as observers at five other stations were equally fortunate. Australia, though less well situated, was as well provided for as India. Mr. Ellery, of Melbourne, and Mr. Russell, of Sydney, organized and trained observers most carefully, more

than twelve of whom met with the most complete success. Mr. Tebbutt of New South Wales, Mr. Stone at the Cape, and others in Ceylon, Mauritius, and even Malta procured useful results. Among private observers we must not omit to mention Col. Campbell and Admiral Ommanney, who were stationed in Egypt, and Lord Lindsay, whose private expedition to Mauritius was probably the most complete, both as regards men and material, sent out by any country, and who obtained results of very great value, in spite of the loss of the contacts at ingress. The Imperial Astronomer of Russia, Prof. Struvé, met with less success than he had a right to anticipate, nineteen failures being registered against eight partial and five complete successes. The entire failure of the heroic attempt of M. Bouquet de la Grye, sent by France to Campbell Island, was in part compensated by the remarkable good fortune of Capt. Mouchez at St. Paul's; and the observations of Dr. Janssen at Nagasaki were well worthy of his high repute as an astronomer. France also was well represented at Pekin. Germany and America secured some excellent results, but envious clouds seem to have somewhat marred their efforts at most of their stations. Austria, Holland, and Italy have also added some valuable details.

The accuracy of the results, and the consequent degree of approximation to the true solar distance, now attained, can only be correctly estimated after a most careful examination of the observations themselves; but from what we know of the extreme care taken in the longitude determinations and of the nature of the contacts, as also of the excellence of the photographs, we may predict with confidence that the labour and expense will not have been in vain. But apart from the times of contact and the measures of the photographs, which require long and persevering labour previous to their discussion, many results have been obtained which are of value in themselves, and also from throwing light on what should be done in 1882. Beginning with what may have attracted less attention, we notice that among the many measures taken for determining the apparent diameter of Venus, by which her size is found in terms of her distance, three observers in particular paid special attention to the shape of the planet. At Mauritius, Dr. Copeland, rotating one image of Venus round the other in the double image eye-piece, could detect no trace of ellipticity, and Dr. Auwers observing in Egypt confirmed this result by

one hundred and four measures of the diameter. Yet, on the other hand, we learn that Col. Tennant finds a slight departure from the circular form in the twenty-eight differences of declination and forty of right ascension which he took of the two limbs of the planet.

Again, an observation made by Tacchini in India confirms the statement first published, I believe, by Padre Secchi, that the diameter of the sun as seen through the spectroscope is smaller than that visible to the unassisted eye, which is equivalent to saying that the brighter portion of the chromosphere, which lies immediately on the photosphere, is brilliant enough to make a sensible addition to the solar diameter. This was shown by the times of internal contact at egress, as the contact occurred earlier when observed through the spectroscope than when viewed directly by the telescope.

Dr. Janssen has thrown considerable light on the comparison of photographs with eye observations, by taking a photograph of the sun at ingress at the moment of apparent internal geometrical contact. The picture shows that photographic contact had not yet taken place. This result was confirmed by a plate of forty-seven photographs.

The existence of a bright spot on the surface of Venus was noticed by Russell in Australia and Pringle in India. The former gives its position as near the pole of the planet. It might therefore, as has been already pointed out, be due to the increase of refractive power with the intensity of cold in the planetary atmosphere.

Another observation made by Dr. Janssen previous to first external contact is well worthy of remark. Knowing the chromosphere to be very rich in violet rays, and therefore choosing a tint of glass capable of cutting off a very large portion of the photospheric light without diminishing in any similar proportion the brilliancy of the chromosphere, he was able to see the dark body of the planet projected on a brighter background as it approached the edge of the sun. The description given by Mr. Henderson, of Victoria, of Venus as distinctly visible on a faint phosphorescent looking background, would lead us to suppose that he had also seen the planet on the chromosphere; and this is also the impression conveyed by the words in which Mr. Todd, of Adelaide, relates what he himself witnessed. Some of the photographs taken when Venus was only partially on the sun are an apparent confirmation that Venus might be seen by

aid of the chromosphere; but without a careful examination of the negatives, it is dangerous to draw any positive conclusions from these pictures.

A question very fully discussed during the preparations for the late transit, concerning the reality of a phenomenon at internal contact called the Black Drop, appears to have been fairly answered by the observations of 1874. The Government Astronomer at the Cape, Colonel Walker, Messrs. Hunter and Tebbutt, and two out of the thirteen observers of Mr. Russell, are the only persons who could detect any approach to the true Black Drop, where the planet is drawn out in the direction of the sun's limb so as to appear egg-shaped, or, rather, pear-shaped. Mr. Hennessey observed at the same station in India as Col. Walker, but at a height greater by four thousand three hundred feet, and he attributes his not seeing the drop to the greater clearness of the atmosphere. This cause alone would certainly be insufficient to account for all the observations; but considering the very large number of practised observers who were watching the transit with the expectation of witnessing the phenomenon, and yet could not detect the least trace, it is no slur on any one to attribute the appearance to some peculiarity of atmospheric conditions, or of instrument, or even of a personal nature. Besides those mentioned above, there were some few others, as Capt. Fleuriat and Messrs. Meldrum, Moerlin, and Gore, who saw no change of form in the planet, but still could detect traces of a true ligament. The number, however, was very great of those who observed a slight shadow between the two limbs before or after the joining of the cusps at ingress or their formation at egress. In some cases this haziness was accompanied by a tremulous motion, denoting a disturbing action of the atmosphere. The instantaneous photographs of internal contact seem not to favour the view of the reality of the Black Drop.

Another appearance, witnessed by most of those who, under favourable circumstances, took part in the late observations, deserves our most careful attention. In 1761, Chappe, with more than six other observers, saw a faint ring of light round that portion of the limb of Venus which was off the sun, and in 1769 the same phenomenon is recorded by an equal number of astronomers. Maskelyne describes the ring as a vivid but narrow and ill-defined border of light, which he lost sight of before contact. During the last transit this border of light,

seen by so many in every portion of the globe where the sun was visible, is generally described as a faint silvery light, totally different from the brilliant sunlight, but closely resembling moonlight. It was in 1874 well defined and abruptly terminated. In the report given by Wall it is described as a fine, clear, delicate line of light, which became clearer as internal contact approached at ingress. Pringle says that the ring was of the same thickness throughout; but Tebbutt found it much broader along the northern regions, and Gilbert in the northwest. Tacchini examined it with his spectroscope, and discovered that it contained aqueous vapour. During the transits of 1761 and 1769 several observers also saw a faint ring round Venus when she had entered wholly on the sun. Hitchens says that it was excessively white and faint. Messrs. Gore and Ellery examined Venus very carefully in 1874, but could see nothing of this ring, and Col. Campbell, Prof. Auwers, and Dr. Dölln only perceived it when near the limb of the sun. On the contrary, it appeared to Nairne in 1769 brighter and whiter than the body of the sun, and Russell reports that during the late transit it was manifestly brighter than the sun. Mr. Hennessey also saw this ring round the limb of Venus whilst on the sun. The photographs are adduced in confirmation of the excessive brilliancy of the ring, but the extra deposit of silver around Venus in the negatives may possibly be otherwise satisfactorily explained. The existence of an atmosphere round Venus may, however, be considered as fully established, and this must necessarily have an important bearing on the contact observations, explaining the gradual submergence of the planet and other observed phenomena, for which observers could scarcely have been prepared by their previous model practice.

The gradual accumulation of most of the above details served to occupy some of our hours of leisure during the long journey from Ceylon to Malta, and though the results as here presented may require some modification as fuller and more accurate accounts are gradually published, they may be considered as a first rough outline of what has been done.

• As we touched at several places on our way home we were able to utilize these opportunities by determining the elements of terrestrial magnetism. For this purpose a unifilar and dip circle had been kindly placed at my disposal by the Director of the Kew observatory. With these instruments we were only

able to obtain observations at one station on our way out, but returning we observed the declination, dip, and horizontal force at Bombay, Aden, Port Said, Malta, Palermo, Naples, Rome, Florence, and Turin. We might also have used the instruments in France had we not already completed a magnetic survey of that country in 1868 and 1869. During our stay at Kerguelen frequent observations had been made of the earth's magnetism at our principal station, and also at four other places on the same islands.

On reaching Malta we had finally to bid adieu to Capt. Fairfax and the officers and men of the *Volage*, from whom we had throughout the expedition received so many acts of kindness and attention, and to whom any success we may have obtained is in great measure due. A parting dinner, with the expression of the kindest wishes, and a farewell address from one of the men in the name of his companions, accompanied by a poetic effusion descriptive of the incidents of the voyage, were fresh proofs, where none were wanted, of the generous spirit in which one and all had endeavoured to carry out most perfectly the object of our expedition. H.M.S. *Volage* arrived safe at Portsmouth a few weeks later, and the results of our labours were at once deposited in the hands of the Astronomer-Royal, Sir G. B. Airy, who bore the burden of the preparations, and who is now actively superintending the reduction of the observations.



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